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Fig. 15. Comparison of the crop damage caused by different application techniques at two application times in winter wheat: (a) shallow I (C2) - June; (b) shallow I (C2) - July; (c) slipperfoot (C1) - June; (d) slipperfoot (C1) - July; (e) dribble (C2D)-June; (f) dribble (C2D)

Table 1
Field data

	<i>Year one</i>				<i>Year two</i>				
Field	Ivy Ground	Avenue		Showground	Home Close				
Soil type	Clay	Sandy Loam		Sandy Loam	Clay				
Soil series	Evesham**	Cottenham**		Cottenham**	Evesham**				
Field capacity (%)*	55.6	20.0		20.0	55.6				
Upper plastic limit (%)	61.9	-		-	61.9				
Lower plastic limit (%)	32.5	-		-	32.5				
Cropping									
Previous crops	1993/94 Winter wheat 1994/95 Winter rape		1993/94 Winter rape 1994/95 Winter wheat		1995/96 Winter rape			1995/96 Winter wheat	
Crop type/variety	Winter wheat Brigadier		Winter rape Express		Winter wheat Brigadier			Winter wheat Riband	
Planting	21/09/95		20/09/95		19/09/97			28/10/97	
1st granular fertiliser	02/02/96		30/01/96		10/03/97			10/03/97	
2nd granular fertiliser	29/03/96		28/03/96		04/04/97			04/04/97	
Sludge									
Code	Date	Total N, kg/ha	Date	Total N, kg/ha	Code	Date	Total N, kg/ha	Date	Total N, kg/ha
a	09/11/95	67.3	09/11/95	67.3	a	12/12/96	108.2	12/12/96	108.2
b	12/12/95	102.0	12/12/95	102.0	b	04/02/97	119.1	04/02/97	119.1
c	28/02/96	115.9	14/02/96	100.8	c	27/03/97	87.1	27/03/97	87.1
d	29/04/96	119.1	12/03/96	109.2	d	07/03/97	91.0	07/03/97	91.0
e	03/06/96	102.8	18/04/96	101.0	b/c	04/02/97	119.1	04/02/97	119.1
f	04/07/96	78.7	10/05/96	95.5		27/03/97	87.1	27/03/97	87.1

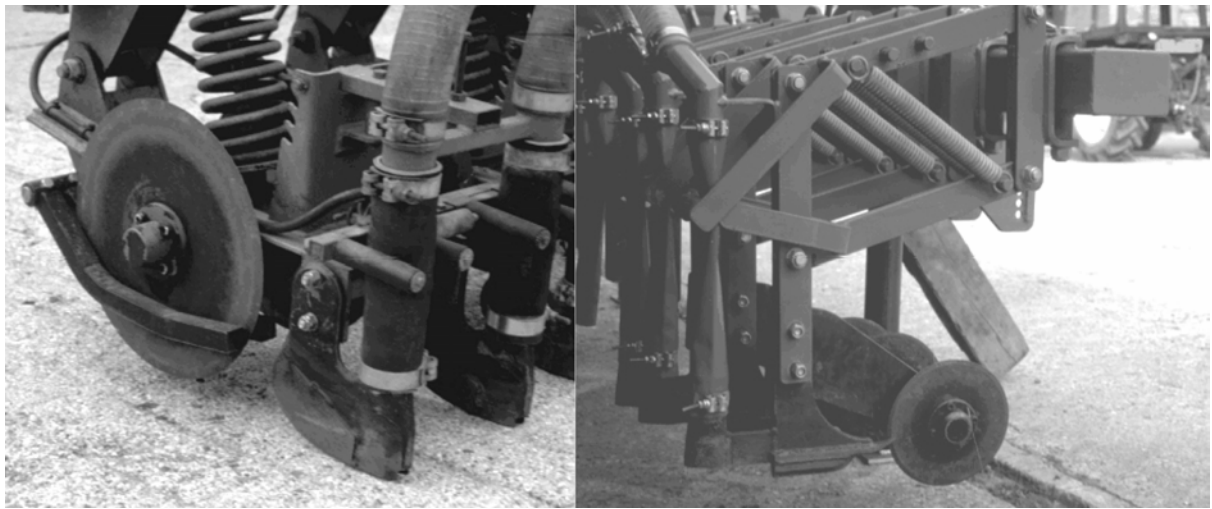
* Gravimetric MC (%) at 2 pF, ** King 1969.

Table 2
Analysis of results - year one

<i>Comparisons</i>	<i>Clay</i> <i>Ivy Ground - Wheat</i>		<i>Sandy loam</i> <i>Avenue - Rape</i>	
	<i>F pr.</i>		<i>F pr.</i>	
Control versus rest of experiment	<0.001	***	0.570	NS
Fertilised and unfertilised controls versus rest of experiment	0.455	NS	0.535	NS
Controls versus treatments with and without sludge	1.44	NS	0.712	NS
Controls versus application technique	<0.001	***	0.738	NS
Controls versus application time	<0.001	***	<0.001	***
Controls versus technique and time of application	<0.001	***	0.320	NS
Controls versus technique with and without sludge	0.348	NS	0.485	NS
Controls versus application time with and without sludge	00.619	NS	0.319	NS
Controls versus technique/time of application with/without sludge	0.868	NS	0.515	NS

Table 3
Soil moisture content at different
application times

<i>Date</i>	<i>Sandy loam Showground</i>	<i>Clay Home Close</i>
12/12/96	21.6 %	41.7 %
14/02/97	20.8 %	39.1 %
27/03/97	13.3 %	30.0 %
07/05/97	14.6 %	28.9 %



(a)

(b)

Fig. 1. Alternative commercial injectors: (a) shallow I (C2); (b) slipperfoot (C1)



Fig. 2. Single piece tine with leg profile III and 40 mm wing or single piece tine (S5)

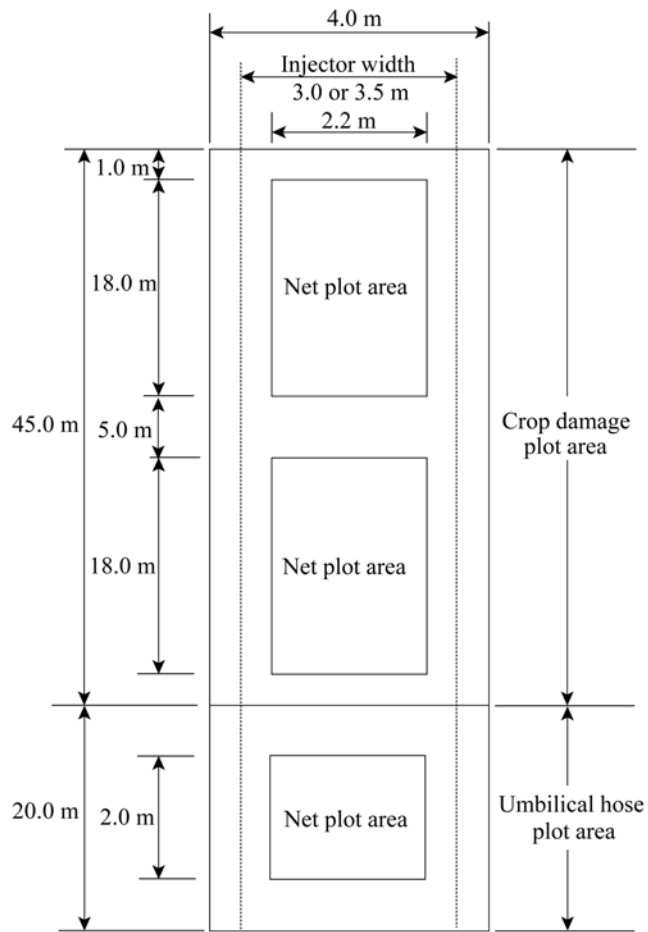


Fig. 3. Plot layout - year one trials

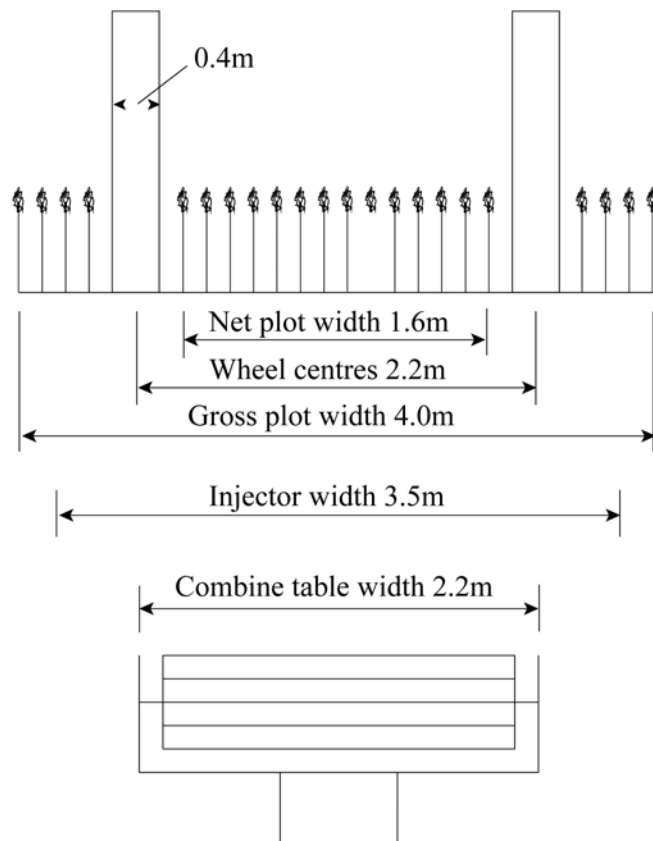


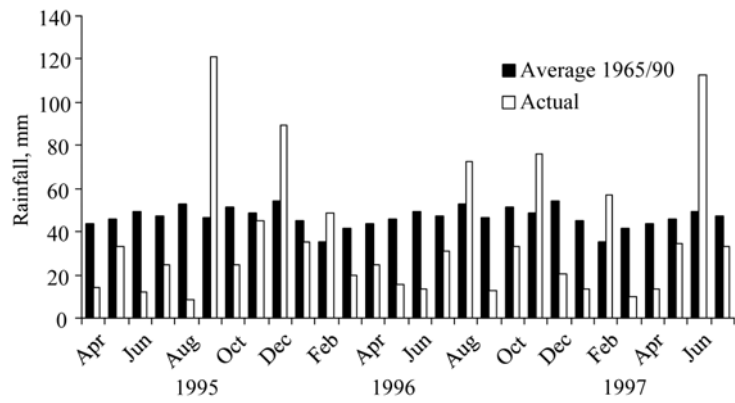
Fig. 4. Plot layout - year two trials



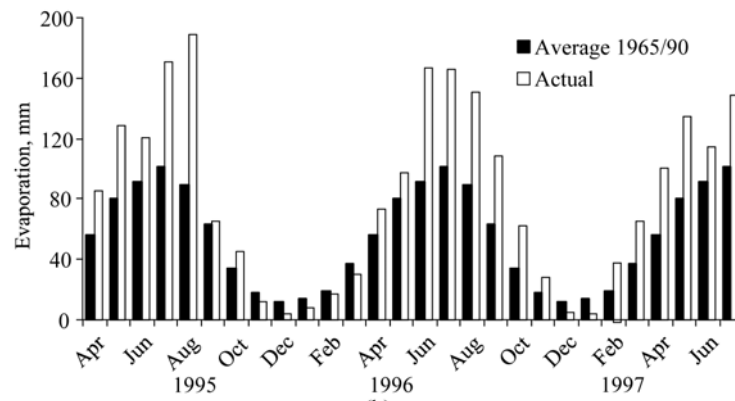
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Fig. 6. Umbilical hose trials



(a)



(b)

Fig. 7. Weather conditions: (a) rainfall; (b) evaporation

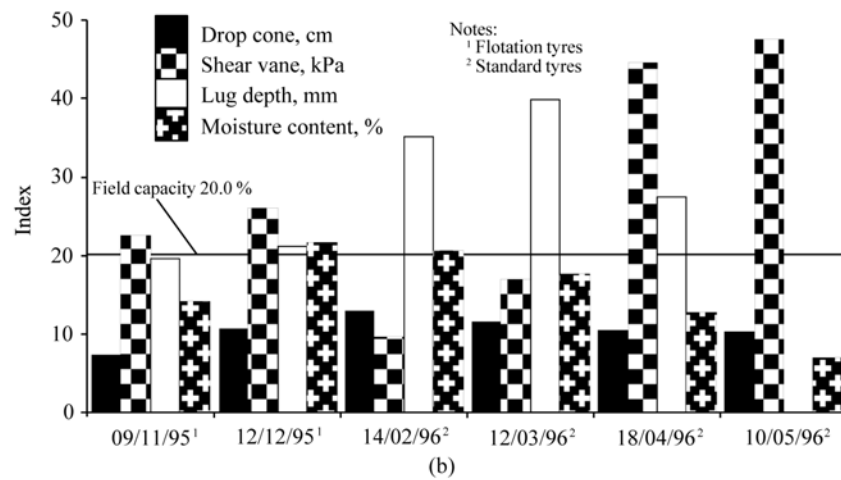
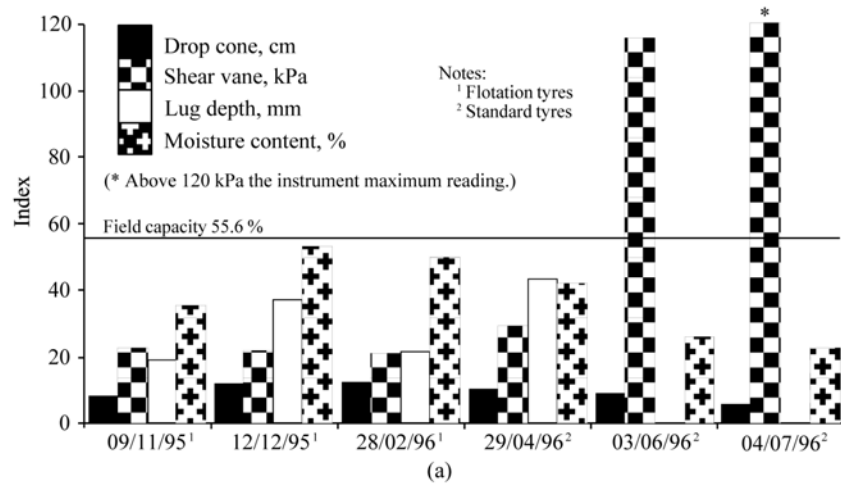


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(a) Ivy Ground - clay - Evesham; (b) Avenue - sandy loam - Cottenham

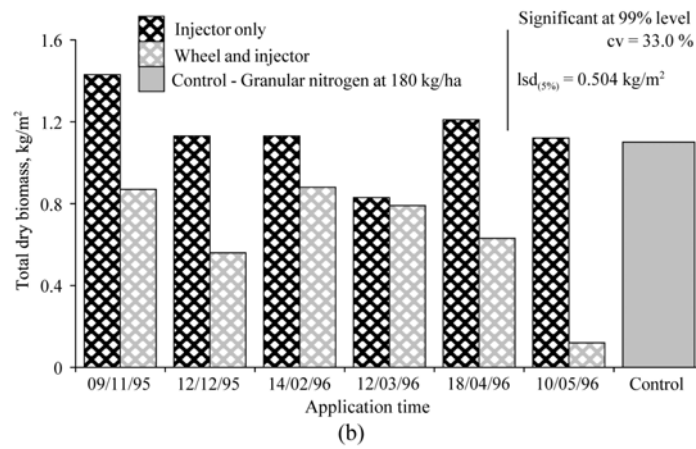
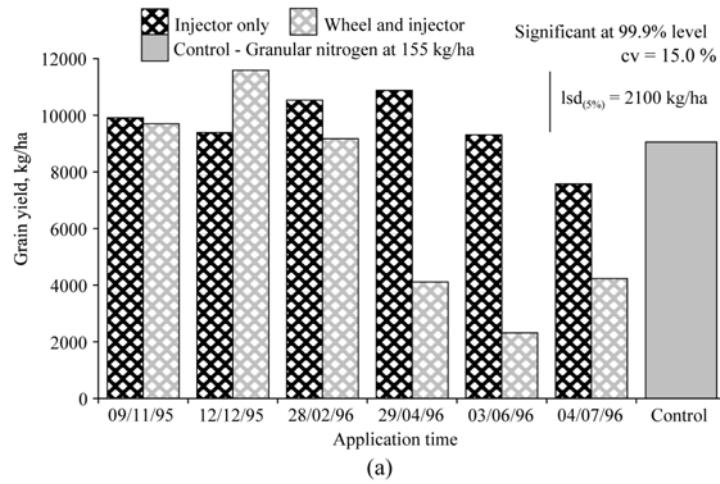


Fig. 9. Relative damage behind injector & wheel: (a) winter wheat - clay soil; (b) winter rape - sandy loam soil

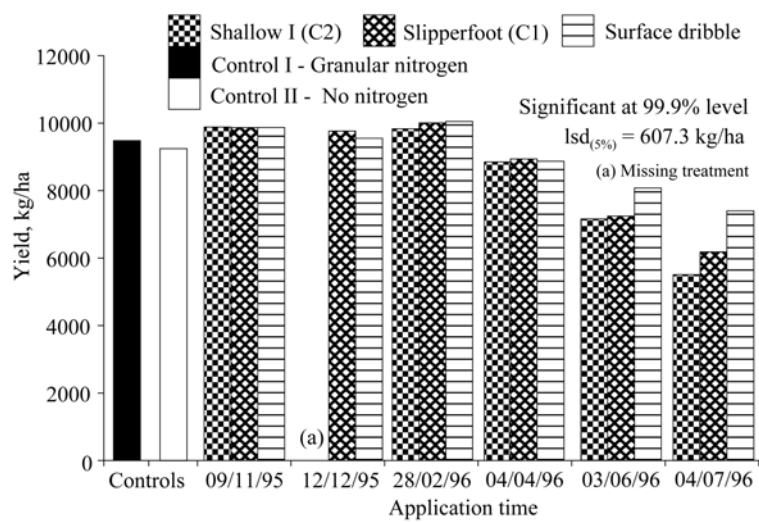


Fig. 10. Effect of application technique and time on winter wheat yield - year one trials

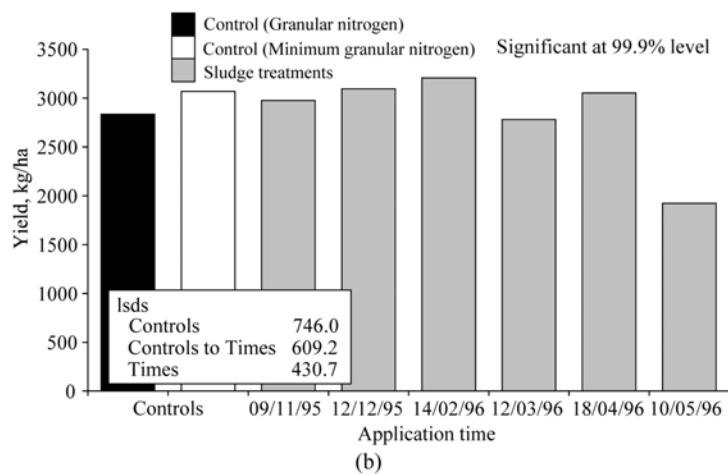
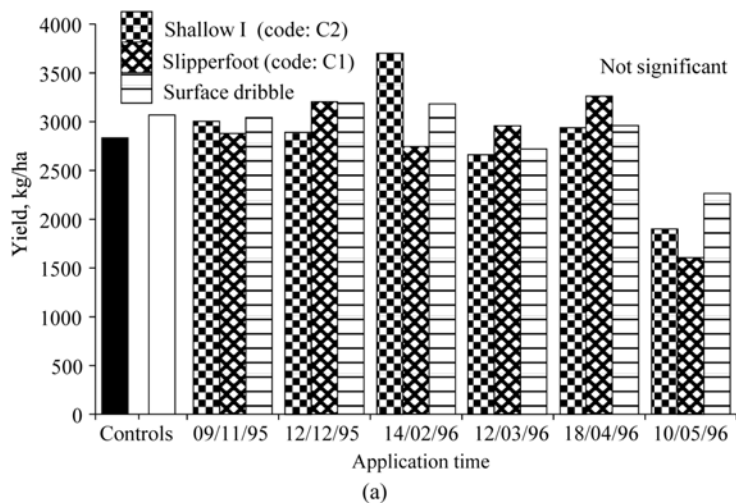


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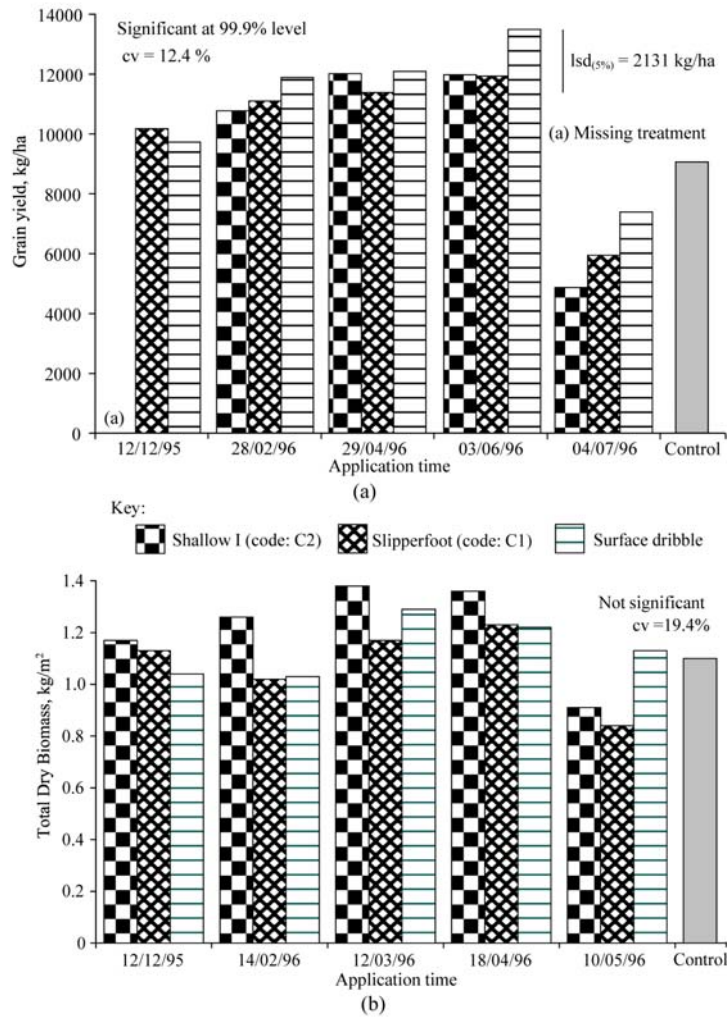


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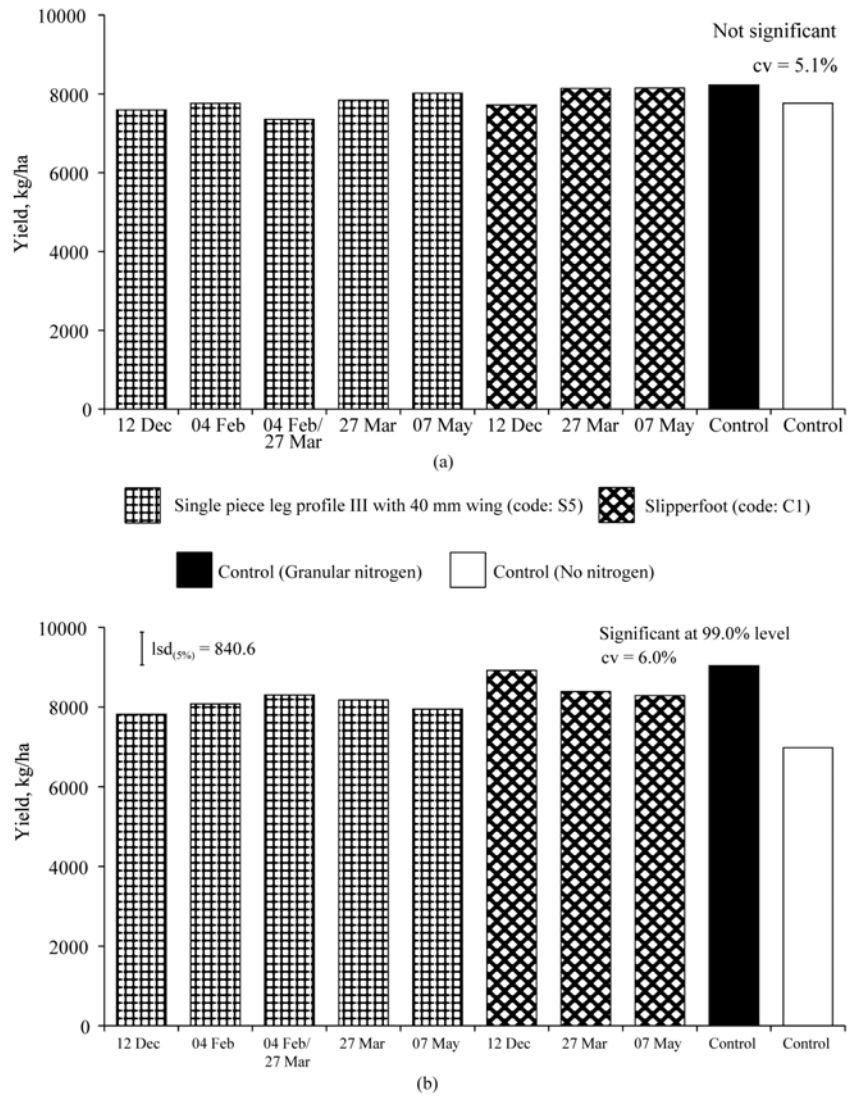


Fig. 13. Final yield results - year two trials: (a) Showground - sandy loam soil; (b) Home Close - clay soil



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Injecting bio solids into grass and arable crops. Part II: Development of a shallow application technique

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